

Light Microscopy Module Imaging Tested and Demonstrated

The Fluids Integrated Rack (FIR), a facility-class payload, and the Light Microscopy Module (LMM), a subrack payload, are integrated research facilities that will fly in the U.S. Laboratory module, Destiny, aboard the International Space Station. Both facilities are being engineered, designed, and developed at the NASA Glenn Research Center by Northrop Grumman Information Technology. The FIR is a modular, multiuser scientific research facility that is one of two racks that make up the Fluids and Combustion Facility (the other being the Combustion Integrated Rack). The FIR has a large volume dedicated for experimental hardware; easily reconfigurable diagnostics, power, and data systems that allow for unique experiment configurations; and customizable software. The FIR will also provide imagers, light sources, power management and control, command and data handling for facility and experiment hardware, and data processing and storage. The first payload in the FIR will be the LMM. The LMM integrated with the FIR is a remotely controllable, automated, on-orbit microscope subrack facility, with key diagnostic capabilities for meeting science requirements--including video microscopy to observe microscopic phenomena and dynamic interactions, interferometry to make thin-film measurements with nanometer resolution, laser tweezers to manipulate micrometer-sized particles, confocal microscopy to provide enhanced three-dimensional visualization of structures, and spectrophotometry to measure the photonic properties of materials. Vibration disturbances were identified early in the LMM development phase as a high risk for contaminating the science microgravity environment. An integrated FIR-LMM test was conducted in Glenn's Acoustics Test Laboratory to assess mechanical sources of vibration and their impact to microscopic imaging. The primary purpose of the test was to characterize the LMM response at the sample location, the x - y stage within the microscope, to vibration emissions from the FIR and LMM support structures.



LMM and FIR integrated test configuration.

Long description. The Light Microscopy Module is shown here integrated with the Fluids Integrated Rack. The configuration is very similar to the on-orbit configuration aboard the International Space Station. The Imaging techniques were tested in this configuration with Fluids Integrated Rack operational at Glenn's Acoustics Test Laboratory.

The imaging tests were performed, as close as possible, in an on-orbit configuration in the Acoustics Test Laboratory, as shown in the photograph. Launch bolts to the optics bench were removed, and the Air Thermal Control Unit (ATCU) was unlocked and supported by Lord isolators (Lord Corporation, Cary, North Carolina). Isolating foam was installed into the FIR, and all rack openings were closed and sealed to minimize acoustic disturbances. The LMM spindle assembly, the mechanism to structurally mount the LMM microscope, was bolted to the front of the optics bench. The FIR was configured with its various diagnostics and avionics as it would be during on-orbit operations with the LMM, and the LMM was mounted in its flightlike configuration onto the optics bench within the FIR. The main microgravity disturbers, fans located in the ATCU and the input/output processor, were on during the testing. Images of test target slides and sample cells mounted on the LMM x - y stage were captured while the FIR ATCU and input/output processor were running inside the FIR. Initial measurements indicated that the fans in the ATCU were the driving microgravity disturber. The ATCU was operated through the full range of operating fan speeds, 1600 to 2600 rpm, while acquiring images at a frame rate of 30 Hz. In addition, with the FIR powered down to create a vibration-quiet environment, a small shaker was attached to the FIR optics bench to induce vibratory excitation so that frequency disturbances that cause image degradation could be determined.

The preliminary results revealed that, in general, the ATCU and small vibration shaker tests caused no image degradation. However, at a magnification of $\times 100$, image

degradation was observed above a frequency of 30 Hz with the ATCU operational, and with induced low-vibration excitations. At lower frequencies, the combined LMM-FIR configuration meets microgravity requirements. The test results have led the LMM team to design isolation techniques for the LMM x - y stage to prevent image degradation at high magnifications and at frequencies above 30 Hz.

Find out more about this research:

Light Microscopy Module (LMM) at <http://microgravity.grc.nasa.gov/6712/lmm.html>
Glenn's Acoustics Test Laboratory at <http://www.grc.nasa.gov/WWW/AcousticalTest/>
Glenn's Microgravity Science Division at <http://microgravity.grc.nasa.gov/>

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